

Mobile Source Modeling

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Overview

- Highway Vehicles
 - MOBILE6.2
- Nonroad Sources
 - NONROAD and HAP emissions
 - Aircraft, Commercial Marine Vessels, Locomotives

MOBILE6.2

- Applies toxic fractions to TOG
- Accounts for differences in toxic fractions between:
 - technology groups,
 - driving cycles
 - normal and high emitters
 - gasoline fuel properties
 - Data inadequate to account for fuel property impacts on toxic fractions for diesels
- Can also estimate emissions of other hazardous air pollutants (HAPs) based on user provided information
- Module fully integrated into MOBILE6 framework
 - recommended by National Academy of Sciences

MOBILE6.2

- HAPs estimated using MOBILE6.2
 - 13 Gaseous Compounds
 - 16 particulate and vapor phase PAHs
 - 3 particulate phase metal compounds

MOBILE6.2

- Benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, MTBE explicitly modeled
 - benzene and MTBE: component of evaporative and exhaust emissions
- Other pollutants estimated with “ADDITIONAL HAPS” command
 - requires user provided external datafile

MOBILE6.2

- Explicitly modeled HAPs:

$$\text{Toxic EF} = \text{Toxic/TOG ratio} * \text{MOBILE6 TOG} * \text{ADJ}_{\text{UC/FTP}}$$

Where:

Toxic/TOG Ratio = g/mi toxic from air toxic module/ g/mi TOG from air toxic module

$\text{ADJ}_{\text{UC/FTP}}$ = difference in exhaust toxic/TOG ratio between Federal Test Procedure (FTP) and Unified Cycle (UC)

MOBILE6.2

- Gasoline Vehicle exhaust:
 - Complex Model/MTBE fuel effects model algorithms used for post-1981 light duty vehicles
 - Based on 1990 fleet, but test data too limited to develop separate algorithms for advanced technology vehicles (e.g Tier 2)
 - Off-cycle adjustments from a small speciation database from CARB test program
 - For older technology vehicles, motorcycles, HDGVs, more simplified exhaust equations used

MOBILE6.2

- Light and heavy duty diesel exhaust:
 - Based on tests of a few engines
 - Data inadequate to account for fuel property impact on toxic fractions for diesels
- Gasoline vehicle evaporative -- algorithms from Complex Model/MTBE fuel effects model used for all gasoline vehicles

MOBILE6.2

- In addition to MOBILE6.0 inputs, the following additional fuel parameters are required:
 - % aromatics
 - % olefins
 - % benzene
 - E200 -- percentage of vapor a gasoline produces at 200 degrees F
 - E300
 - Oxygenate type and % of total volume

MOBILE6.2

- Sources of base year fuel parameter data
 - Alliance of Automobile Manufacturers Survey
 - TRW Petroleum Technologies Survey (formerly NIPER)
 - EPA RFG Surveys
- Projections to future years
 - Use existing refinery modeling work
 - Do new refinery modeling or evaluate what changes are likely based on judgement
 - Make inferences from other areas

MOBILE6.2

- Other pollutants modeled using “ADDITIONAL HAPs” command
 - User provided inputs:
 - ratios of toxics to TOG or VOC (gaseous HAPs)
 - ratios of toxics to PM (PAHs)
 - basic emission rates (metals)
 - Additional HAPs files developed for several fuel types
 - baseline, MTBE oxygenated, ethanol oxygenated

MOBILE6.2

- MOBILE6.2 Executable, User's Guide, “ADDITIONAL HAPS” input files, example input and output files
 - <http://www.epa.gov/otaq/mobile6/mobile62.zip>
- MOBILE6.2 Technical Documentation
 - <http://www.epa.gov/otaq/models/mobile6/r02029.pdf>
- County level fuel parameters used in draft 1999 NEI, v. 3
 - <ftp://ftp.epa.gov/EmisInventory/draftnei99ver3/haps/datafiles/onroad/auxiliaryfiles/>

MOBILE6.2 Example Input File

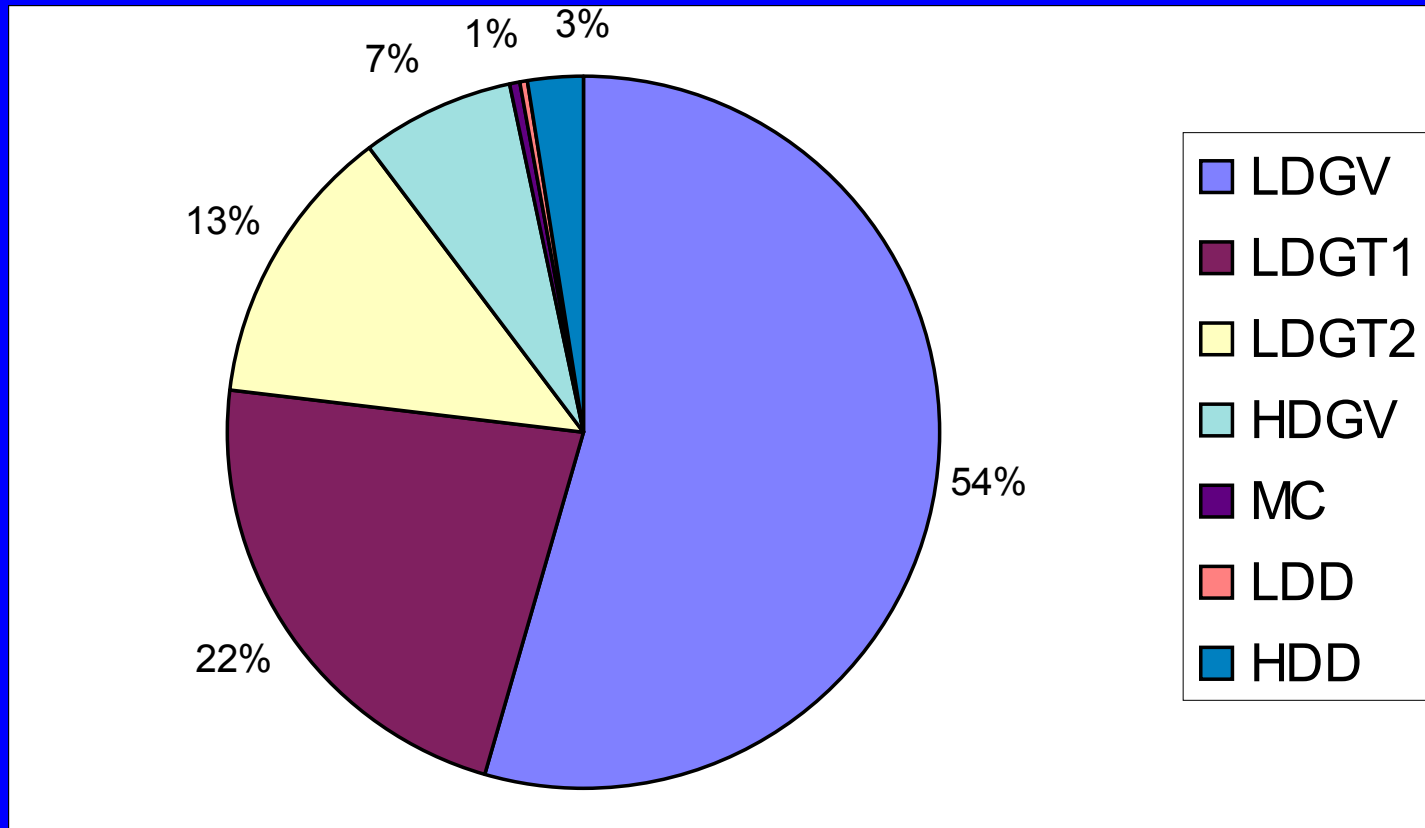
MOBILE6 INPUT FILE

AIR TOXICS :
SCENARIO REC : Example Input File
CALENDAR YEAR : 2002
SULFUR CONTENT : 30.0
MIN/MAX TEMP : 68.0 84.0
FUEL RVP : 7.0
GAS AROMATIC% : 25.0
GAS OLEFIN% : 15.0
GAS BENZENE% : 1.5
E200 : 50.0
E300 : 85.0
OXYGENATE : MTBE 15.1 0.50
 : ETBE 17.6 0.05
 : ETOH 10.0 0.45
 : TAME 6.0 0.00
ADDITIONAL HAPS : HAP_BASE.CSV
END OF RUN :

Inventory

Contribution of Vehicle Classes to Total U. S. Highway Vehicle
HAP Emissions in the 1999 NEI

Total = 1.5 million tons



NONROAD and HAP Emissions

- NONROAD:
 - Requires no user data
 - All Nonroad Sources (*except locomotives, aircraft and commercial marine*)
 - Differentiated by Equipment Type and Other Characteristics
 - HC, CO, NO_x, PM, SO_x, CO₂
 - HAPs not currently included
 - Fuel Consumption

NONROAD and HAP Emissions

- NONROAD Overview
 - Past, Present and Future Year Inventories
 - Temporal Allocation
 - Geographic Allocation
 - seasonal, weekday, weekend

NONROAD and HAP Emissions

- NONROAD Overview
 - Input Options
 - Year
 - Temporal Period
 - Geographic Area
 - Equipment Types
 - Fuel Characteristics
 - Output Options
 - ASCII File
 - Pre-formatted MS Access Reports
 - Access not required
 - Access database
 - Excel Spreadsheet

NONROAD and HAP Emissions

- Model Overview
 - Pre-Formatted Reports
 - By County
 - By Source Category
 - By Equipment type/code
 - By Horsepower

NONROAD and HAP Emissions

Exhaust Emissions Calculation

$$I = EF \cdot DF \cdot Act \cdot LF \cdot RP \cdot Pop$$

I = Exhaust Emissions Inventory (ton/year)

EF = Emission Factor (g/hp-hr)

DF = Deterioration Factor

Act = Activity (hours/year)

LF = Load Factor

RP = average rated power (hp)

Pop = Equipment population (units)

NONROAD and HAP Emissions

- NONROAD June 2003 release
 - <http://www.epa.gov/otaq/nonrdmdl.htm>

NONROAD and HAP Emissions

- County-level HAP emissions estimated in NEI as follows:
 - Gaseous HAPs -- toxics ratios applied to VOC
 - vary by fuel type
 - PAHs -- toxics ratios applied to PM
 - PAH ratios include gas and particle phase PAH mass
 - Metals -- basic emission rates (metals) X National Activity/Fuel Usage
 - emissions allocated to county level based on county/national PM ratios

NONROAD and HAP Emissions

- Speciation data used to develop ratios
 - Very limited, based on a small number of tests for a few equipment types
 - where data don't exist for equipment types, data for equipment with similar engines used
 - little known about impacts of operating cycles
 - Data lacking for equipment with emission controls
 - EPA has recently completed speciation analyses for 14 Nonroad CI engines, and is beginning testing of 27 small gasoline engines
 - data will be used to improve inventories

Aircraft

- Criteria Pollutant Emission Factors in NEI
 - Commercial -- FAA Emissions and Dispersion Modeling System (EDMS)
 - Air Taxi, General Aviation, Military -- default Values from 1992 EPA Guidance (Volume IV)
 - <http://www.epa.gov/otaq/inventory/r92009.pdf>
- Landing/Take Off (LTO) data
 - FAA Air Traffic Data

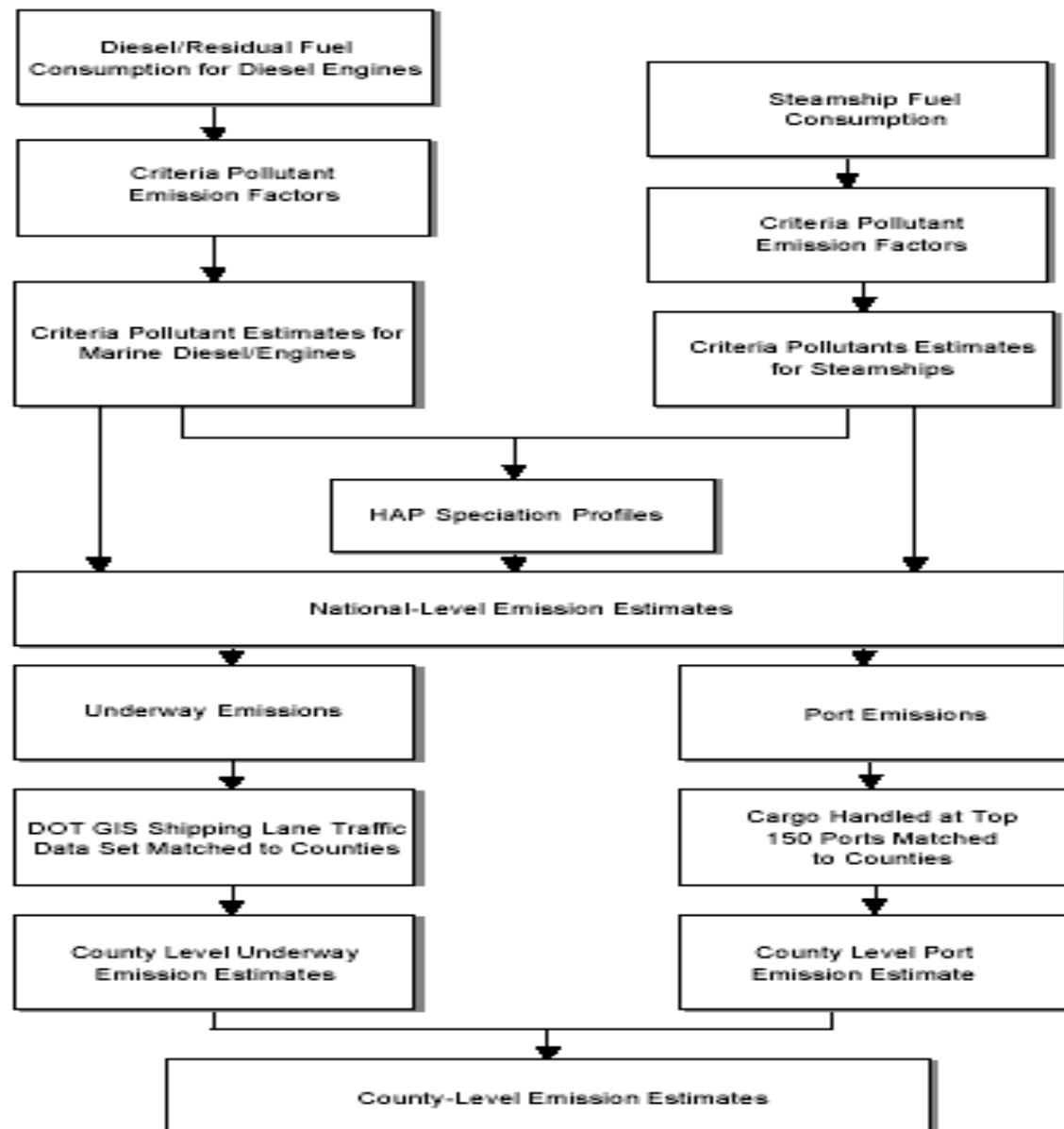
Aircraft

- HAP Speciation Data for turbine engines from one military engine tested in 1984
 - military fuel used; similar to commercial
 - profile ignores unresolved species
 - likely overestimate of HAPs
 - Does not account for differences in taxi/idle operations among airports
 - recent military data suggest significant differences between turbofan, turboprop, turbojet, turboshaft

Aircraft

- No speciation data for piston engine aircraft
 - non-catalyst highway vehicle profile used as surrogate
- No metal emissions data

Commercial Marine



Commercial Marine

- No speciation data
 - Heavy duty diesel vehicle profile used for diesel marine
 - Stationary and industrial boiler profiles used for steamships

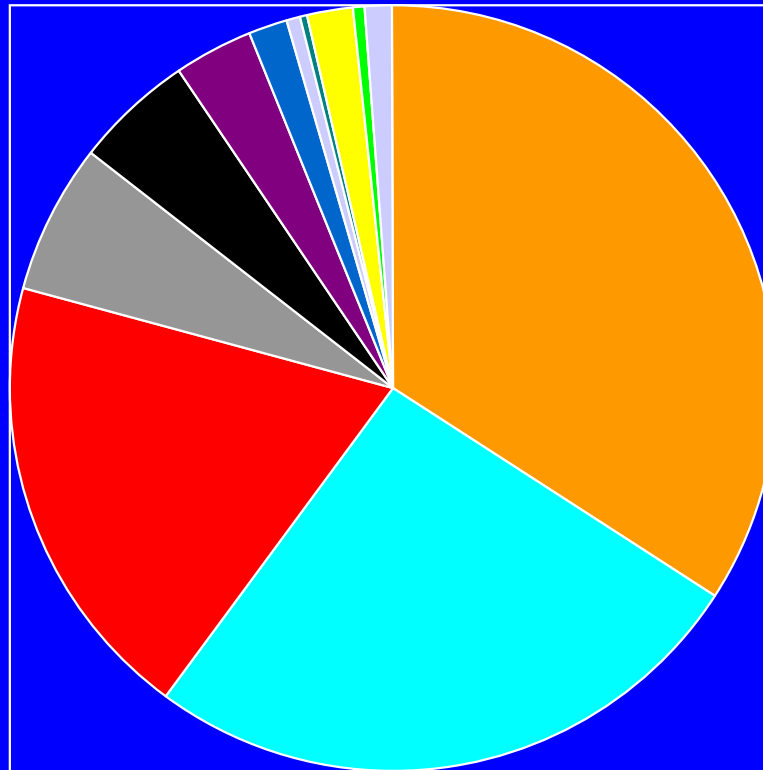
Locomotives

- Criteria Pollutant Nationwide Emissions in NEI
 - Product of DOE fuel oil sales and emission factors from EPA
- HAP speciation data
 - From 2000 testing by Southwest Research Institute for ARB
- County allocation
 - DOT GIS rail activity database

Inventory



Total =
760,000 tons



Documentation for Nonroad HAPs

- NEI for HAPs, draft v. 3
 - Appendix D of nonroad documentation
 - <http://www.epa.gov/ttn/chief/net/index.html#haps99>

Estimation of Mobile Source Emissions Below County Level

- Can use an air quality model emission processor such as EMS-HAP
 - allocates emissions to census tracts or grid cells using surrogates
 - e.g., roadway miles, land use, population
- For refined local scale analyses, can develop link level highway vehicle inventory
 - use link level VMT data (traffic counts or travel demand model data)